GENERAL NOTES

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CATOCALA (NOCTUIDAE) TAKEN AT SHENANDOAH NATIONAL PARK, VIRGINIA,WITH COMPARATIVE NOTES ON ADULT FLIGHT PHENOLOGIES IN EASTERN NORTH AMERICA

Additional key words: light trap, collecting methods, Lepidoptera.

In this paper we provide an initial list of *Catocala* species captured in light traps at Shenandoah National Park, Page County, Virginia, and compare our results with those published recently for New England (Sargent, T. D. 1977, J. Lepid. Soc. 31:1–16) and Tennessee (Miller, W. A. 1977, J. Lepid. Soc. 31:197–202). We also compare these trap records to historical sampling data from several other sites in eastern North America, and test the conventional wisdom that different *Catocala* species fly in a largely predictable sequence throughout the summer, irrespective of where one collects.

Our *Catocala* records are drawn from 1989 light trap surveys for Lepidoptera in Shenandoah National Park, which were undertaken to monitor the impact on non-target insects of aerially applied *Bacillus thuringiensis* (*Bt*). Nine portable light traps ("General Purpose Black Light Trap" of O. B. Enterprises, Oregon, Wisconsin) were used to capture adult insects in both *Bt* and untreated sites within Shenandoah National Park. Each trap was outfitted with a 15-watt fluorescent black light bulb and powered by a 12-volt gel-cell battery. A custom designed solar switch activated each trap system at dusk and turned it off at dawn. A combination of ethyl acetate and DDVP (*Vapona* strips) was used to kill trapped insects. Labelling of specimens was done in the field, and the material was stored frozen for subsequent sorting, identification, and counting. Each trap was usually (but not always) operated only one night per week during the period 12 May to 3 October 1989, with insects being removed from the traps as early as possible on the following morning. All traps were spaced at least 200 m apart, and insofar as possible were placed in sites with similar aspect (facing northwest) and elevation (ca. 1000 m). Full details of the spraying and trapping regimes as they relate to the *Bt* work will be presented elsewhere.

Table 1 lists the *Catocala* captured in all nine traps, by species and week of sampling. A total of 1034 individuals was collected, representing 23 species. The earliest capture date was 26 June, and the last date was 2 October. As is usually the case with *Catocala* light trap samples (see Sargent, T. D. 1976, *Legion of Night*, Univ. Mass. Press, Amherst, Massachusetts, 222 pp.), only a few species comprised the majority of our captures, with over two-thirds of all specimens being *C. cerogama* Gueneé, *ilia* Cramer, *palaeogama* Gueneé, and *lineella* Grote (see Gall, L. F. 1989, Psyche 97:121–129 for re-elevation of *lineella* to species rank, and other taxonomic decisions regarding the "*amica* Hübner complex").

The total of 23 *Catocala* species for 1989 at Shenandoah is similar to yearly totals recorded at light traps in New England: between 26–35 species in Washington, Litchfield County, Connecticut, during the period 1961–1973; 29–30 species in West Hatfield, Hampshire County, Massachusetts, 1969–1973; and 24–30 species in Leverett, Franklin County, Massachusetts, 1970–1973 (see appendices in Sargent 1976, *op. cit.*). Miller (1977, *op. cit.*) did not present yearly totals for Celina, Clay County, Tennessee, but 41 was his cumulative species total for the period 1970–1976 at that locality. For the New England localities, the cumulative species totals were 39, 37, and 33, respectively, and it seems certain from these comparative data and field experience in Virginia (including knowledge of available local *Catocala* larval foodplants) that the cumulative species total for Shenandoah National Park can be expected to eventually exceed 30.

At Shenandoah, different *Catocala* species clearly flew at different times of the year, and for all species but *cerogama* the two sexes seemed to have similar flight seasons (the

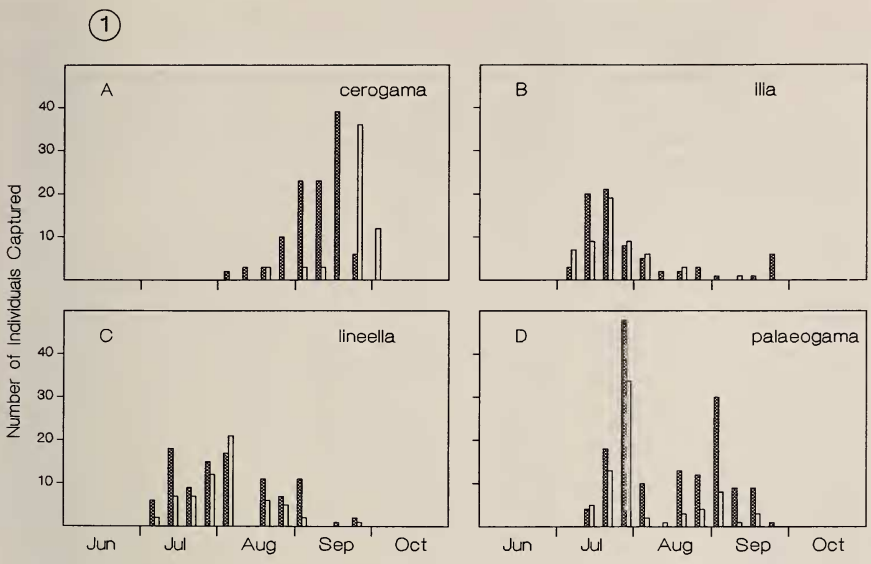

Fig. 1. Seasonal abundance profiles for the four most common *Catocala* listed in Table 1. Hatched bars, males; open bars, females.

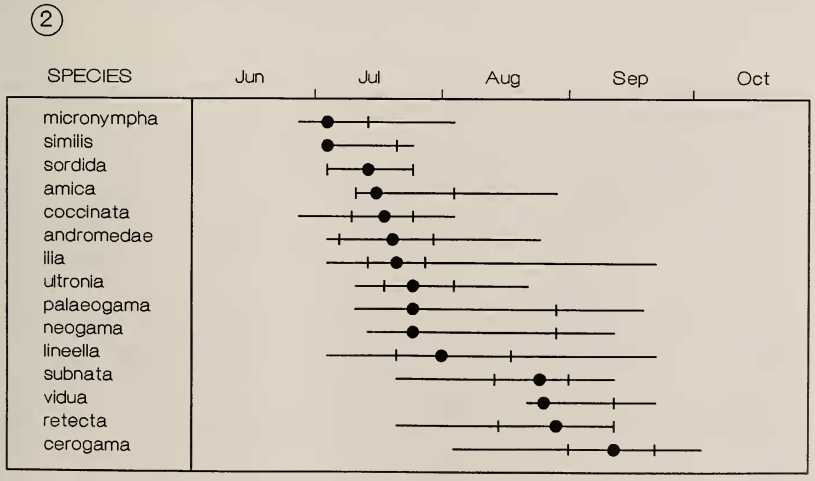

Fig. 2. Seasonal occurence of *Catocala* listed in Table 1 having 10 or more total captures. Ends of horizontal lines represent first and last capture dates; vertical hatch marks, first and third quartiles; solid circles, median capture dates. Species ordered vertically by increasing median capture date. Modeled after Fig. 4 of Sargent (1977). See text for discussion and statistical analysis.

TABLE 1. *Catocala* species collected in Shenandoah National Park, Page County, Virginia at UV light traps during 1989.

Catocala species	26 Jun thru 02 Jul	03 Jul thru 09 Jul	10 Jul thru 16 Jul	17 Jul thru 23 Jul	24 Jul thru 30 Jul	31 Jul thru 06 Aug	07 Aug thru 13 Aug
amica Hbn.	0	0	7	1	2	2	0
andromedae Gn.	0	7	4	3	4	5	0
blandula Hlst.	0	2	0	1	4	0	0
cara Gn.	0	0	0	1	0	0	0
cerogama Gn.	0	0	0	0	0	2	3
coccinata Grt.	1	25	12	15	15	11	0
epione Dru.	0	0	2	1	1	1	0
flebilis Grt.	0	0	0	0	0	0	0
ilia Cram.	0	10	29	40	17	11	2
judith Stkr.	0	0	0	0	0	1	0
lacrymosa Gn.	0	0	0	0	0	0	0
lineella Grt.	0	8	25	16	27	38	0
micronympha Gn.	3	48	7	5	11	2	0
nebulosa Edw.	0	0	0	0	1	0	0
neogama J. E. Sm.	0	0	1	0	6	0	0
palaeogama Gn.	0	0	9	31	82	12	1
relicta Wlkr.	0	0	0	0	0	0	0
retecta Grt.	0	0	0	1	0	1	0
similis Edw.	0	7	0	3	1	0	0
sordida Grt.	0	4	4	0	3	0	0
subnata Edw.	0	0	0	1	4	3	2
ultronia Hbn.	0	0	2	6	6	3	0
vidua J. E. Sm.	0	0	0	0	0	0	0
Totals	4	111	102	125	184	92	8

cerogama males were captured earlier than the females); these patterns can be seen in the seasonal histograms for the four most common species (Fig. la–d). To quantify these trends, an analysis of variance (ANOVA) was performed with date of capture as the dependent variable and sex and species as independent, using those species from Table 1 for which both males and females were captured. The ANOVA revealed a significant species effect ($F = 86.24$, $df = 17/992$, $P < 0.01$), a non-significant sex effect ($F = 0.91$, $df = 1/992$, $P = 0.34$), and a significant sex by species interaction ($F = 2.84$, $df = 17/992$, $P < 0.01$), with that interaction being traceable to *cerogama* ($F = 0.77$, $df = 16/807$, $P = 0.72$ without it).

Fig. 2 presents flight phenologies at Shenandoah National Park in 1989 for the 15 *Catocala* species having 10 or more captures, with species ordered vertically by increasing median capture date. Our Fig. 2 is modeled after Fig. 4 of Sargent (1977, *op. cit.*), which shows the same information for 30 *Catocala* species at Washington, Connecticut.

Miller (1977, *op. cit.*) did not present median capture dates for Celina, Tennessee, but the dates of his first captures are available for comparisons with the Shenandoah and Washington data. In addition, dates of first captures are given in the literature for: the 1877–1881 seasons at Frankford, Philadelphia County, Pennsylvania (Johnson, J. S. 1882, Can. Entomol. 14:59–60); the 1877 season at Centre, Albany County, New York (Bailey, J. S. 1877, Can. Entomol. 9:215–218); and the 1911–1913 seasons at Louisiana, Pike County, Missouri (Rowley, R. R. & L. Berry 1914, Entomol. News 25:157–167). Table 2 presents the first and median capture dates at all six localities, when determinable, for the 34 species that are present at two or more localities. All available species are used from the Frankford and Louisiana lists (where total captures are not stated), whereas

TABLE 1. Continued.

14 Aug thru 20 Aug	21 Aug thru 27 Aug	28 Aug thru 03 Sep	04 Sep thru 10 Sep	11 Sep thru 17 Sep	18 Sep thru 24 Sep	25 Sep thru 01 Oct	02 Oct thru 08 Oct	Totals
0	0	2	0	0	0	0	0	14
0	1	0	0	0	0	0	0	24
0	0	0	0	0	0	0	0	7
0	0	0	0	0	0	0	0	1
6	10	26	26	39	42	12	21	187
0	0	0	0	0	0	0	0	79
1	1	0	0	0	0	0	0	7
0	1	1	0	1	0	0	0	3
5	3	1	1	1	6	0	0	126
0	0	0	0	0	0	0	0	1
0	0	0	0	0	1	0	0	1
17	12	13	0	1	3	0	0	160
0	0	0	0	0	0	0	0	76
0	0	0	0	1	0	0	0	2
1	0	2	0	2	0	0	0	12
16	16	38	10	12	1	0	0	228
0	0	0	0	1	0	0	0	1
1	2	3	0	3	0	0	0	11
0	0	0	0	0	0	0	0	11
0	0	0	0	0	0	0	0	11
2	12	8	5	3	0	0	0	40
4	1	0	0	0	0	0	0	22
0	6	0	1	1	2	0	0	10
53	65	94	43	65	55	12	21	1034

only those species having 10 or more total captures are used from the other four localities. Because *amica* was distinguished from *lineella* only at Shenandoah National Park, these two species are omitted from Table 2.

Distinctive species-specific patterns of adult seasonality are evident in Table 2, and these patterns appear to be geographically consistent, despite differences in the overall timing of *Catocala* flight from locality to locality. For example, in the three recent samples, *micronympha* Guenée flies earlier than *andromedae* Guenée, which in turn flies earlier than *retecta* Grote—and all capture dates for these three species are earliest at Celina, intermediate at Shenandoah National Park, and latest at Washington.

In order to quantify these geographical similarities in flight phenologies, the data in Table 2 were treated as nine column vectors, and these were tested against one another for association using Spearman rank correlation. Each of the 36 possible comparisons among the nine vectors yielded a positive rank correlation—the values ranging from $r = +0.50$ through $r = +0.96$, with 32 of 36 being significantly positive ($P < 0.01$ for twenty two, $P < 0.05$ for ten). This clearly establishes that the order in which different *Catocala* species fly during the season is consistent at all six localities.

Note that light trapping was the sole collecting method used at Shenandoah National Park and Washington; artificial bait was the only method at Centre; "tree tapping" was used exclusively at Frankford and Louisiana; and a combination of light, bait, and tapping was used at Celina. Artifical bait is known to attract certain species of *Catocala* better than others (e.g., Kellogg, C. & T. D. Sargent 1972, J. Lepid. Soc. 26:35–49), and there is also some indication that phenologies derived from bait captures may at times differ from phenologies derived from other collecting methods (unpublished field data of L. F.

TABLE 2. Dates of first and median capture for 34 *Catocala* species collected in Washington, Litchfield County, Connecticut (CT, data from Sargent 1976); Shenandoah National Park, Page County, Virginia (VA, data from present paper); Centre, Albany County, New York (NY, data from Bailey 1877); Celina, Clay County, Tennessee (TN, data from Miller 1977); Frankford, Philadelphia County, Pennsylvania (PA, data from Johnson 1882); and Louisiana, Pike County, Missouri (MO, data from Rowley & Berry 1914). Species ordered vertically by increasing first capture date at Washington, Connecticut (when possible). See text for discussion and statistical analysis.

Catocala species	Earliest capture date						Median capture date		
	CT	VA	NY	TN	PA	MO	CT	VA	NY
blandula Hlst.	7/05	—	7/07	—	—	6/21	7/13	—	7/19
micronympha Gn.	7/05	6/26	7/20	6/22	—	—	7/20	7/03	7/25
coccinata Gr.	7/06	6/26	—	—	—	6/28	7/18	7/17	—
andromedae Gn.	7/08	7/03	—	6/23	—	—	8/02	7/19	—
unijuga Wlkr.	7/08	—	7/07	—	—	—	8/22	—	8/07
epione Dr.	7/09	—	7/09	6/21	7/10	6/21	8/02	—	7/24
ilia Cram.	7/10	7/03	7/07	6/20	7/01	6/20	8/17	7/20	7/20
antinympha Hb.	7/11	—	7/11	—	—	—	8/02	—	—
ultronia Hb.	7/11	7/10	7/11	6/23	7/08	6/21	8/04	7/24	7/23
grynea Cram.	7/12	—	7/17	—	7/01	7/13	8/06	—	7/23
praeclara Gr. & Rob.	7/13	—	7/12	—	—	—	8/02	—	7/30
palaeogama Gn.	7/16	7/10	7/20	7/05	7/11	7/03	8/02	7/24	8/10
concumbens Wlkr.	7/19	—	7/14	—	—	—	8/25	—	—
dejecta Stkr.	7/19	—	—	6/24	—	6/28	8/03	—	—
serena Edw.	7/19	—	—	—	7/11	—	8/11	—	—
judith Stkr.	7/21	—	—	6/25	7/09	—	8/03	—	—
residua Gr.	7/25	—	7/25	7/04	—	7/06	8/19	—	8/07
submata Gr.	7/26	7/20	—	7/05	7/14	—	8/10	8/24	—
parta Gn.	7/29	—	—	—	7/21	6/28	9/12	—	—
retecta Gr.	7/30	7/20	7/30	7/05	7/19	—	9/02	8/28	8/29
neogama J. E. Sm.	7/31	7/13	—	7/05	7/10	7/06	9/06	7/24	—
insolabilis Gn.	—	—	—	7/04	7/08	7/05	—	—	—
cerogama Gn.	—	8/03	7/25	7/04	8/08	7/19	—	9/11	—
nebulosa Edw.	—	—	—	7/05	—	7/05	—	—	—
lacrymosa Gn.	—	—	—	7/16	—	7/13	—	—	—
piatrix Gr.	—	—	—	—	8/10	8/07	—	—	—
flebilis Gr.	8/02	—	—	7/05	7/26	8/02	8/27	—	—
obscura Stkr.	8/08	—	—	7/04	7/10	—	9/06	—	—
cara Gn.	8/10	—	7/31	—	8/06	7/12	9/13	—	8/10
habilis Gr.	8/11	—	7/30	7/31	7/25	7/19	9/14	—	8/16
angusi Gr.	—	—	—	7/31	—	7/29	—	—	—
amatrix Hb.	—	—	—	—	8/09	7/28	—	—	—
vidua J. E. Sm.	—	8/21	8/18	8/01	8/09	7/31	—	8/25	8/19
robinsoni Gr.	—	—	—	—	8/10	8/16	—	—	—

Gall and D. F. Schweitzer). An attempt was therefore made to modify the Celina phenologies to reflect largely the results of light trapping and tree tapping, by deleting six species for which bait accounted for more than half of all captures (*cerogama, ilia, obscura* Strecker, *residua* Grote, *retecta*, and *vidua* J. E. Smith), and repeating the analyses. Because the correlations involving Celina remained significant upon retesting ($r = +0.62$ to $r = +0.83$, $P < 0.05$ for all), the bait and light/tapping phenologies at Celina appear not to have differed appreciably.

These results corroborate the conventional wisdom relied upon by *Catocala* collectors for years—namely, that relative adult flight periods for different species are predictable, irrespective of regional differences in the overall timing of *Catocala* flight. It is especially noteworthy that the phenological correlations hold across six geographically distant localities that have only partially overlapping assemblages of *Catocala* species and their larval foodplants. In light of the considerable research on *Catocala* adult and larval communities conducted primarily in New England (see Sargent 1976, *op. cit.*; Gall, L. F. 1987, Oikos 49:172–176, and 1991a–c, J. Res. Lepid. 29, *in press*), this consistency in phenologies suggests that a number of the ecological paradigms drawn from the New England work will be applicable to *Catocala* faunas elsewhere in deciduous forests of eastern North America.

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HAWK MOTHS (SPHINGIDAE) IN THE WHITLEY COLLECTION FROM WALKER COUNTY, TEXAS

Additional key words: phenology, zoogeography.

Surprisingly little is known of the hawk moths (Sphingidae) of Texas. R. W. Hodges (1971, Sphingoidea, Fasicle 21, The moths of America north of Mexico, Wedge Entomol. Found. & E. W. Classey Ltd., London, 158 pp.) reported records of many species from Texas, although few specific localities were provided. The bibliography in Hodges (*op. cit.*) included no publications that list and analyze the sphingid fauna of any part of Texas, although two publications cited by Hodges discuss the sphingids of neighboring Arkansas (Freeman, H. A. 1938, Field & Lab. 6:33–43; Selman, C. A. & H. E. Barton 1971, Arkansas Acad. Sci. Proc. 25:56–58).

Here I report on a collection of sphingids from Walker County in east central Texas that is part of the Michael Whitley collection, now in the the Entomology Collection of the Houston Museum of Natural Science (HMNS). Most specimens were collected from 10 July 1971 to 19 May 1987 approximately 13 km SW of Huntsville or on the outskirts of Huntsville itself (Walker County). Specimens were collected at white light, UV light, fruit baits, and by casual daylight collecting. All specimens were collected by Michael Whitley and his family.

The climate of Walker County (data from Huntsville), is humid, warm temperate. Mean annual temperature is 19.4°C and mean annual precipitation is 1123 mm. Typically, 101 days a year have a daily maximum temperature above 32.2°C and 26 days have a daily mimimum temperature below 0°C. The growing season averages 265 days (7 March to 27 November). Rainfall averages over 65 mm for each month, but warm season thunderstorms produce slight precipitation peaks in April/May and September. On average, 65 days a year experience at least 2.5 mm of precipitation; snow is uncommon.